

placed through the collar. As a result, the circumferentially spaced members 44 have a wedge shape and a height which tapers towards the central passageway 45 defined by the collar, which facilitates displacing the head of the securing element therethrough and reversibly enlarging the passageway 45. In the embodiment illustrated in FIG. 13, the collar is integrally formed with the stabilizing element 41 at the anterior end of the transverse passageway, and defines the first opening 16 in the stabilizing element 41. The securing element may be the same as, or similar to, the securing element 14 discussed above in connection with the embodiment illustrated in FIG. 1, and as illustrated in FIG. 13. However, securing element 30 having head 34 with a compressed configuration and an uncompressed configuration, as discussed above in connection with the embodiment illustrated in FIG. 7, may also be used. FIG. 15 illustrates a plan view of the assembly shown in FIG. 14, taken along lines 15—15, with the head of the securing element 14 partially in phantom. The angular and longitudinal displacement of the securing member in the posterior section 25 of the transverse passageway is as discussed above.

The stabilizing element is preferably formed of a metal such as titanium or stainless steel. The length of the stabilizing element is typically about 7 to about 300 mm, preferably about 13 to about 200 mm, and the width of the stabilizing element is typically about 5 to about 50 mm, preferably about 10 to about 30 mm. The height of the stabilizing element is typically about 0.5 to about 10 mm, preferably about 1.0 to about 6.0 mm although the dimensions of the stabilizing element will vary depending on the application for which the assembly is to be used.

The securing element is preferably formed of a metal, such as titanium or stainless steel. The head of the securing element is configured, as for example with a hexagonal opening, for releasable connection to a tool for advancing the securing element into the bone. The body of the securing element has a length of about 2 to about 50 mm, preferably about 5 to about 20 mm, and the head of the securing element has a length of about 0.05 to about 1.5 mm, preferably about 0.5 to about 1.0 mm. One skilled in the art will recognize that a variety of suitable securing elements may be used, which may be optimized for use in a particular orthopedic environment, as is well known in the art. For example, a high thread pitch may be used to limit screw back out from bone.

The assembly of the invention is suitable for use in a variety of medical procedures, including securing fractured bone segments or vertebrae following disk removal. In the illustrated embodiments, the stabilizing element comprises a plate, although other suitable elements such as rods may be used. Additionally, the stabilizing element may be shaped to conform to the surface of the bone or bones to which it will be attached. For example, a presently preferred embodiment of the stabilizing element comprises a plate with a concave posterior surface, and is configured for attaching to vertebrae.

While the present invention has been described herein in terms of certain preferred embodiments, those skilled in the art will recognize that modifications and improvements may be made without departing from the scope of the invention. For example, while the stopping member is discussed primarily in terms of a collar, other configurations may also be used. Additionally, while a particular feature may be discussed in connection with one embodiment, it should be understood that features of one embodiment may be used with the other embodiments herein.

What is claimed is:

1. An orthopedic implant assembly, comprising
 - a) a stabilizing element having an anterior surface, a posterior surface, and at least one bore, the bore having a first opening in the anterior surface, a second opening in the posterior surface smaller than the first opening, and a transverse passageway extending from the first opening to the second opening;
 - b) a biased stopping member defining at least in part a reversibly expandable passageway having a smaller diameter configuration and a larger diameter configuration; and
 - c) a securing element having an elongated body, and a head at one end of the body and integral therewith, the head having a maximum diameter greater than the smaller diameter configuration of the passageway defined by the biased stopping member and greater than the second opening in the stabilizing element, so that the head is retained within the transverse passageway between the biased stopping member and the second opening in the stabilizing element.
2. The assembly of claim 1 wherein the biased stopping member comprises a collar defining a passageway, enlargable from an unexpanded inner diameter to an expanded inner diameter, wherein the head of the securing element has a maximum diameter greater than the unexpanded inner diameter of the collar and less than the expanded inner diameter of the collar.
3. The assembly of claim 2 wherein the head of the securing element has a curved posterior surface which has a minimum outer diameter smaller than the unexpanded inner diameter of the collar, configured to be displaceable posteriorly of the collar through the passageway of the collar from an anterior to a posterior surface thereof.
4. The assembly of claim 2 wherein the bore has a groove in an anterior portion of the transverse passageway having a diameter and a height, and wherein the collar is a reversibly expandable annular collar seated in the groove, the collar having an expanded outer diameter, and an unexpanded outer diameter which is less than the diameter of the groove and greater than a diameter of the transverse passageway.
5. The assembly of claim 4 wherein the head of the securing element has a curved posterior surface which has a minimum outer diameter smaller than the unexpanded inner diameter of the collar, and which is configured to contact the collar anterior surface and expand the collar as the head is displaced posteriorly through the collar passageway.
6. The assembly of claim 2 wherein the collar is secured to an anterior section of the transverse passageway, and has a plurality of slots and circumferentially spaced members, the circumferentially spaced members having a deflected configuration defining the expanded inner diameter of the collar.
7. The assembly of claim 6 wherein the head of the securing element has a curved posterior surface which has a minimum outer diameter smaller than the unexpanded inner diameter of the collar, and which is configured to contact the collar anterior surface and deflect the circumferentially spaced members away from a longitudinal axis of the transverse passageway as the head is displaced posteriorly through the collar passageway.
8. The assembly of claim 6 wherein the collar has an anterior surface which tapers toward a center of the transverse passageway.
9. The assembly of claim 3 wherein a posterior portion of the transverse passageway is curved to conform to the curved posterior surface of the head.

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10. The assembly of claim 1 wherein the head of the securing element is longitudinally displaceable within the transverse passageway between a posterior surface of the biased stopping member and the second opening in the posterior surface of the stabilizing element.

11. The assembly of claim 10 wherein the body of the securing element has a diameter smaller than the second opening in the stabilizing element, and the securing element may be angularly displaced within the transverse passageway and the second opening in the stabilizing element.

12. The assembly of claim 1 wherein the stabilizing element includes at least two bores.

13. The assembly of claim 1 wherein the stabilizing element is configured to conform to and extend between at least two bone segments.

14. The assembly of claim 13 wherein the stabilizing element has a curved surface.

15. The assembly of claim 1 wherein the stabilizing element is selected from the group consisting of rods and plates.

16. The assembly of claim 1 wherein the securing element is selected from the group consisting of screws and nails.

17. The assembly of claim 2 wherein the collar is formed of an elastically deformable material.

18. The assembly of claim 2 wherein the collar is formed of a material selected from the group consisting of titanium and superelastic material.

19. The assembly of claim 2 wherein the collar has a posterior surface perpendicular to a longitudinal axis of the transverse passageway.

20. The assembly of claim 4 wherein the collar has a height less than the height of the groove.

21. A method of attaching an orthopedic implant assembly to a bone of a patient, comprising

- a) positioning a stabilizing element against a surface of the patient's bone, the stabilizing element having an anterior surface, a posterior surface, and at least one bore, the bore having a first opening in the anterior surface, a second opening in the posterior surface smaller than the first opening, and a transverse passageway extending from the first opening to the second opening, and a biased stopping member within the bore and defining at least in part a reversibly expandable passageway having a smaller diameter configuration and a larger diameter configuration;
- b) providing a securing element having an elongated body, and a head at one end of the body and integral therewith, the head having a maximum diameter greater than the smaller diameter configuration of the passageway defined by the biased stopping member and greater than the second opening in the stabilizing element, so that the head is retained within the transverse passageway between the biased stopping member and the second opening in the stabilizing element;
- c) positioning the body of the securing element in the transverse passageway and posteriorly advancing the head of the securing element within the passageway defined by the biased stopping member and thereby displacing the biased stopping member to form the larger diameter configuration passageway defined thereby; and
- d) attaching the stabilizing element to the bone by advancing the head of the securing element posteriorly of the biased stopping member so that the passageway defined thereby returns to the smaller diameter configuration, to position the head within a posterior section of the transverse passageway between the biased stopping

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member and the second opening in the stabilizing element, and to position the body of the securing element within the patient's bone, so that the securing element is attached to the bone and is retained within the posterior section of the transverse passageway of the stabilizing element.

22. The method of claim 21 including, after the head of the securing element is positioned between the biased stopping member and the second opening in the stabilizing element, the step of longitudinally and angularly displacing the head of the securing element within the transverse passageway, so that the body of the securing element is positioned at an angle within the patient's bone relative to the surface of the bone.

23. An orthopedic implant assembly, comprising

- a) a stabilizing element having an anterior surface, a posterior surface, and at least one bore, the bore having a first opening in the anterior surface, a second opening in the posterior surface smaller than the first opening, and a transverse passageway extending from the first opening to the second opening, and a stopping member at an anterior section of the transverse passageway; and
- b) a securing element having an elongated body and a head secured to one end of the body, the head having a reversibly compressed configuration with a compressed diameter less than the diameter of the first opening and an uncompressed configuration with a diameter greater than a diameter of the stopping member and the second opening, so that the head of the securing element is retained within the transverse passageway between the stopping member and the second opening in the stabilizing element.

24. The assembly of claim 23 wherein the head of the securing element is configured to be displaceable posteriorly through the stopping member from an anterior to a posterior surface thereof.

25. The assembly of claim 23 wherein the head of the securing element has a plurality of slots and circumferentially disposed members, the circumferentially disposed members having posterior ends secured to the body of the securing element, and anterior ends radially moveable toward a longitudinal axis of the head of the securing element to form the compressed configuration and away from the longitudinal axis to form the uncompressed configuration.

26. The assembly of claim 23 wherein the stopping member is at the anterior end of the transverse passageway and defines the first opening in the stabilizing element.

27. The assembly of claim 23 wherein the stopping member has a posterior surface perpendicular to a longitudinal axis of the transverse passageway.

28. A method of attaching an orthopedic implant assembly to a bone of a patient, comprising

- a) positioning a stabilizing element against a surface of the patient's bone, the stabilizing element having an anterior surface, a posterior surface, and at least one bore, the bore having a first opening in the anterior surface, a second opening in the posterior surface smaller than the first opening, and a transverse passageway extending from the first opening to the second opening, and a stopping member at an anterior section of the transverse passageway;
- b) providing a securing element having an elongated body and a head secured to one end of the body, the head

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having a reversibly compressed configuration with a compressed diameter less than a diameter of the first opening and an uncompressed configuration with a diameter greater than the diameter of the stopping member and the second opening, so that the head of the securing element is retained within the transverse passageway between the stopping member and the second opening in the stabilizing element;

- c) positioning the body of the securing element in the transverse passageway and posteriorly advancing the head of the securing element within a passageway defined by the stopping member and thereby compressing the diameter of the head of the securing element; and

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- d) attaching the stabilizing element to the bone by advancing the head of the securing element posteriorly of the stopping member so that the diameter of the head of the securing element returns to the uncompressed configuration, to position the head within a posterior section of the transverse passageway between the stopping member and the second opening in the stabilizing element and the body of the securing element within the patient's bone, so that the securing element is attached to the bone and is retained within the posterior section of the transverse passageway of the stabilizing element.

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